

KELLEYVILLE BRIDGE

(Bridge No. 085/101)

New Hampshire Route 11/103, spanning

the Sugar River

Newport vicinity

Sullivan County

New Hampshire

HAER No. NH-27

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD

National Park Service

Northeast Region

Philadelphia Support Office

U.S. Custom House

200 Chestnut Street

Philadelphia, P.A. 19106

HISTORIC AMERICAN ENGINEERING RECORD

KELLEYVILLE BRIDGE (Bridge No. 085/101)

HAER No. NH-27

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LOCATION: New Hampshire Route 11/103, spanning the Sugar River, Newport vicinity Sullivan County, New Hampshire

USGS Newport, NH Quadrangle, Universal Transverse Mercator Coordinates: 18.724810.4804550

ENGINEER/BUILDER: John W. Childs, Bridge Engineer, D. H. Dickinson, Chief Engineer, State of New Hampshire Highway Department. Angus Ferguson, General Contractor, Concord, New Hampshire.

DATE OF CONSTRUCTION: 1933

PRESENT OWNER: New Hampshire Department of Transportation

PRESENT USE: Vehicular Bridge

SIGNIFICANCE: The Kelleyville Bridge is a representative example of a concrete open-spandrel arch deck bridge, typical of early twentieth century concrete bridge technology. The bridge carries Route 11/103 over the Sugar River, a road of historical significance to the state of New Hampshire.

PROJECT INFORMATION: The Kelleyville Bridge was recorded in October, 1995, by the Cultural Resource Group of Louis Berger & Associates, Inc., East Orange, New Jersey, for the New Hampshire Department of Transportation (NHDOT). The recordation was undertaken pursuant to a Memorandum of Agreement between the Federal Highway Administration and the New Hampshire State Historic Preservation Officer executed in association with the planned replacement of the Kelleyville Bridge, Newport, New Hampshire. Project personnel included Richard M. Casella, Senior Architectural Historian, and Rob Tucher, Senior Photographer.

DESCRIPTION

The Kelleyville Bridge (Bridge No. 085/101), built in 1933, is a two-lane six-span reinforced concrete bridge which carries New Hampshire combined State Routes 11/103 in a northwest-southeast direction over the Sugar River and the abandoned right-of-way of the Boston and Maine Railroad. The bridge is located in the Village of Kelleyville, approximately 3.3 miles west of the Town of Newport in Sullivan County.

Kelleyville Bridge consists of an open-spandrel arch center-span, 120' in length, and five concrete T-beam deck spans varying in length between 31'-7" and 35'-0". The total length of the bridge is 314'-6". Three of the deck spans are located on the west side of the river, one spanning the former railroad right-of-way. The center-arch spans the river at a maximum height of approximately 35'.

The arch span consists of the two arch rings measuring 4'-3" wide by 2'-8" deep, spaced 16' apart center-to-center. Deck loads are carried to the arches by a system of spandrel columns and concrete stringers and down to the straight gravity-type abutments. The ring carries 2' square spandrel columns, which in turn support two longitudinal concrete deck girders 9" in thickness and 3'-10" in depth. The concrete deck is 10" in thickness with 15" x 36" cross beams spaced 18' on-center. The bridge does not have sidewalks, and the original concrete open-balustrade railings on the bridge have been replaced with aluminum horizontal rails.

The area around the bridge might best be described as exurban, combining remnants of agricultural activity with roadside commercial enterprise and scattered residences. East of the bridge, is the Kelley House, a two-story brick dwelling and the former residence of Israel Kelley founder of Kelleyville. The highway west of the bridge is characterized by very thinly scattered dwellings and a handful of commercial establishments. The land is relatively open and rolling, with some areas under cultivation.

HISTORICAL INFORMATION

Background

The Town of Newport comprises 25,267 acres, its boundaries forming a generally regular parallelogram. The most important natural feature within Newport is the Sugar River, which, fed from Lake Sunapee, follows a winding, but generally westward course through Newport and Claremont to the Connecticut River. From Newport Center, the Sugar River bends sharply north, and then makes a long curve west, to the Village of Northville, and then back south to Route 11/103 at Kelleyville. Here, the river makes another sharp bend and continues westward into Claremont.

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The Town of Newport was chartered in 1761, among eighteen towns chartered east of the Connecticut that year by Governor Wentworth. The first permanent white settlement occurred in 1766, through the efforts of a small group from Killingworth, Connecticut. They were soon joined by a Baptist colony from Worcester County, Massachusetts, which settled in the northwestern part of Newport, around Northville, and in southwestern Croydon. In addition to farming, settlers were quick to exploit the power potential of the Sugar River, establishing mills along the river and its branches. By 1775, nine years after the first settlement, Newport's population stood at 154 (Upper Valley Lake Sunapee Council 1984b; Wheeler 1879:22-23, 72-73).

Newport's first road was a "cart-road" that ran from North Charleston, through Unity, and into the town over Pike Hill, authorized in March 1766. In 1770, another road was laid out to the Giles mill near the eastern edge of town. The Unity Road, up the west side of the South Branch of the Sugar River, was opened in 1776. Newport's first bridge, over the East Branch near the present Main Street bridge, was authorized in 1774. The following year a second bridge was authorized, to be located on the South Branch near present-day Elm Street (*Newport Business Directory and Advertiser* 1870:21; Wheeler 1879:84-5).

By the beginning of the nineteenth century, nascent villages had formed at several points of good water power: "Southville" on the South Branch in the area of what is now Pollard's Mill Road; "Northville" in the northwest, on the main river; what is now Guild, on the East Branch; and along the East Branch near its confluence with the South Branch. The main village, as envisioned by Newport's original settlers, was located at the foot of Claremont Hill and along Unity and Pine streets, west of the confluence of the South and East branches of the Sugar River. Newport supported a cooper, a saddler, one or more brickmakers, a scythe manufacturer, and a tannery, in addition to sawmills and gristmills.

The earliest names so far associated with the Kelleyville area are Amos Hall and Daniel Dudley. In the fourth division of town lands, Amos Hall was granted a 100-acre lot on the west side of the river, while Daniel Dudley received an 80-acre lot on the east side in the fifth division. The Claremont Road, west from Newport center along the north side of the river, was built in 1779. Kelleyville is named after Israel Kelley, who came to Newport in 1803 from Amesbury, Massachusetts, at the age of 28. Beginning about 1810, Kelley entered into numerous real estate transactions for properties in various locations around the town, and at the same time embarked on a lengthy service as one of Newport's surveyors of highways. In 1827, Kelley established a sawmill on the north side of the road, between the river and what is now Ayers Road. Water was supplied from a canal extending northward along the east bank of the river (Andler 1935; Newport Town Records, Vol. II:442, 538; Sullivan County Deeds 1840:6/351; Wheeler 1879:75, 84, 445).

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In 1834 a new road was built to Claremont through Kelleyville. The means by which the road crossed the river at that time is unknown, but in 1839 Kelley constructed Newport's first covered bridge at the crossing. By 1840, Kelley had built himself a two-story brick house on the north side of the Claremont Road (Route 11/103) just to the west of the bridge, and the settlement around the bridge was commonly known as Kelleyville. The sawmill remained extant until 1938, when it was destroyed by floods during the hurricane of that year. Kelley's brick house remains standing today (Andler 1935; Sullivan County Deeds 1840:6/351; Wheeler 1879:75, 84, 445).

The period between 1830 and 1870 saw the maturation of Newport's agricultural economy and an increasingly intensive utilization of the town's water power for industrial production. The majority of farmers practiced a diversified form of agriculture. By 1840, Newport farmers were growing oats, potatoes, buckwheat, rye, wheat, and Indian corn, and raising cattle, sheep, and a small number of swine. Other products included maple sugar and beans, and nearly all farms were engaged in home manufactures. Newport's industries included two fulling mills and one manufacturer of woolens, plus a small silk mill. Two tanneries were also in operation, as well as two gristmills and no fewer than ten sawmills (Hurd 1886:223; U.S. Bureau of the Census 1841; Wheeler 1879:104-105).

Despite these positive signs, however, Newport's population stagnated, and the aggregate values of the town's farm products declined. During the four decades between 1830 and 1870, the number of inhabitants increased by only 250. As throughout New Hampshire, Newport's agrarian society was gradually forced to compete with farmers in western states who produced huge amounts of agricultural staples cheaply grown and cheaply shipped east along the steadily growing canal and railroad networks. Attempting to maintain their economy, area farmers diversified as much as possible, even adding tobacco to their production by 1870. The lure of inexpensive and notably more fertile lands fostered a "Western emigration fever" that infected more than one farm family. Others were lured by the prospect of living wages to industrial centers in southern New England (Anonymous 1911:251; Hurd 1886:223; U.S. Bureau of the Census 1850, 1853, 1870; Wilson 1936:viii; Upper Valley Lake Sunapee Council 1984b).

Newport's agricultural and industrial economies were also constrained by the lack of a railroad. The Concord and Claremont Railroad Company had been chartered in 1848, and by 1850 a line had been completed as far as Bradford. Construction continued no further, however, due to lack of funds, and for another twenty years Newport was forced to rely on its road system to export its agricultural and industrial products to market. Among those who prospered were the proprietors of the town's hotels, who served teamsters and other road travelers, and the operators of stage lines which connected Newport to Claremont, Lebanon, Lempster, Goshen, and, most importantly, with the railroad line at Bradford (*Newport Business Directory and Advertiser* 1870).

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The Sugar River Railroad Company (later made part of the Concord and Claremont Railroad) was chartered in 1866 and, with substantial local contributions, completed the rail line from Bradford into the town in 1871, extending it to Claremont the following year. The opening of the line ushered in a period of major industrial and commercial growth in Newport. At that time Newport's industries included five flannel mills, two tanneries, three sawmills, a handle manufacturer, a harness maker, and two tailor shops. Newport's industrial growth between 1870 and 1880 spurred a 20% increase in population during the decade, from 2,163 to 2,612. At Kelleyville, the railroad passed along the west side of the river. A small flagman's shack or depot was erected between the tracks and the river at Kelleyville just north of Claremont Road. By 1892, residences had been built on the south side of the highway, with three located between the river and Chandlers Mill Road. In 1894, a post office was established at Kelleyville, remaining in operation until 1918 (Hurd 1886:227-228; U.S. Bureau of the Census 1872; Wheeler 1879:92-93).

The first covered bridge was erected over the Sugar River at Kelleyville in 1839. The bridge stood on wood trestle-work which was "more or less swept away by nearly every spring freshet, thus subjecting the town to inconvenience and expense" (Wheeler 1879:86). The town continued to maintain the bridge until 1900, when "two experienced bridgemen" were hired by the selectmen of Newport to evaluate and report on the structure. Finding the bridge unsafe and beyond repair, the selectmen purchased a new steel truss bridge from the Berlin Iron Bridge Company of Berlin, Connecticut, for \$1,850. The pin-connected through truss had a span of 115', a 15' wide roadway, and a clear height of 17'. The town provided the oak stringers and hemlock decking, which were purchased locally for \$158.22. In addition, the town hired G. W. Kelsey to rebuild the stone abutments at a cost of \$232.25. The completed bridge was opened in 1900 and remained in service until construction of the present bridge in 1933 (New Hampshire State Highway Department 1932; Newport, Town of 1901:25).

Newport's population continued to grow in the first decades of the twentieth century, reaching more than 5,000 inhabitants by the year 1940. Some of the increase may have been attributable to the growing tourist industry, which had been ushered in by completion of the railroad line in the 1870s. Prior to that time, tourism in the Lake Sunapee area was largely the province of the very wealthy; the railroad opened the region to greater numbers of working and middle class "vacationists," who came in increasing numbers as the decades passed (Wilson 1936:277-278). The high point for railroad tourism in and through Newport occurred in 1915, when there were six passenger trains daily, plus two with sleeper cars to Lake Sunapee on weekends. Although tourists continued to pour into the area in subsequent years, the widespread use of automobiles gave them greater flexibility in itineraries, and fewer were funneled, as it were, via the railroad into and through Newport (Newport Bicentennial Commission 1961:46).

By the beginning of the 1930s, Kelleyville consisted of the sawmill, the Kelleyville depot, the three dwellings on the north side of the highway, and a store with gasoline pumps on the south side of the highway (New Hampshire State Highway Department 1932).

History of Kelleyville Bridge

In 1932, Frederick E. Everett, Commissioner of the New Hampshire Highway Department, and the Boston and Maine Railroad petitioned the Public Service Commission for permission to build a new bridge at Kelleyville spanning the Sugar River. The bridge was designed by John W. Childs, Bridge Engineer, and D. H. Dickinson, Chief Engineer of the New Hampshire Highway Department. The impetus for the state to replace the steel truss bridge at Kelleyville was threefold: the truss was no longer capable of carrying the increasingly heavier truck loads; the railroad crossing at grade on the west side of the bridge often backed up traffic onto the bridge and was the scene of numerous train-automobile accidents; and Federal money was available to pay for the entire project (*Argus Champion* 1932:1; New Hampshire State Highway Department 1932).

The bridge was built with monies provided under the Federal Emergency Highway Appropriation Act of 1932, which provided road construction projects for the relief of unemployment (*Argus Champion* 1933a:1). The elimination of dangerous crossings had become a public priority and highway projects undertaken for that purpose received special consideration by the federal government. As highway traffic grew exponentially through the 1920s, the occurrence of accidents at railroad and highway crossings at grade also grew. In 1933 alone, there were 1,511 people killed and 3,697 injured at grade crossings in the United States. Kelleyville Bridge was one of 100 bridges built across the country in 1933 with federal aid to eliminate at-grade crossings. These federal bridge projects totaled over ten miles in length and were constructed at a cost of just over \$4 million (*Roads and Streets* 1934a:447; 1934b:3).

In early 1933, Angus Ferguson of Concord won the award of the contract for construction of the Kelleyville Bridge with the low bid of \$53,020.32. The contract included one-half mile of concrete roadway approaching the bridge, and specified that the contractor employ local help to the extent possible (*Argus Champion* 1933b:1).

By the beginning of April 1933, Ferguson had completed the foundations and abutments of the bridge and was constructing the timber form work for the concrete arch. On Friday, April 14, a heavy rain began falling across the region and continued with practically no let-up for five days. The twin concrete arches were poured and completed, but the rain prevented further concrete work on the columns or the deck. By late Tuesday, of the following week, the Connecticut and Merrimack rivers were approaching record flood levels and were out of their banks, inundating highways, stopping rail traffic, and flooding wide areas of southern New Hampshire. Ferguson and a large corps of his men worked through the night trying to prevent

the buildup of debris against the falsework, and loss of the structure, but to no avail. At four o'clock in the morning, on Tuesday, April 18, the Sugar River, having risen to an estimated 14' above normal, tore the arch from its foundations and carried it away, along with the entire timber falsework. The assemblage of broken concrete and heavy timbers was deposited on an island in the center of the river one-quarter mile downstream. Six workers were on the arch at the time the washout occurred, but escaped to safety just as the bridge tore loose. The workers did manage to save the old metal truss bridge which had been relocated approximately 150' upstream of the new bridge to serve as a temporary crossing (*Argus Champion* 1933a:1).

Following the washout, Ferguson increased the manpower on the job to make up for the lost time. After five months of construction, the bridge opened on July 7, 1933, just five weeks after the originally scheduled June 1 opening date (*Argus Champion* 1933b:1).

History of Reinforced Concrete Open Spandrel Arch Bridges

Although concrete as a structural material was used by engineers in ancient times, the first known concrete bridge built in the United States was the 1871 Prospect Park Bridge in Brooklyn, New York, a non-reinforced-concrete example. The early concrete bridges were arches, following the traditional design technologies of the earlier masonry arch bridges, which required the erection of a temporary structure and framework to hold and shape the liquid concrete prior to its hardening (Plowden 1974:297ff).

Between 1880 and 1895, knowledge of this structural material improved as European engineers tested the capabilities of concrete reinforced with metal components to absorb tensile stresses. The first modern reinforced concrete bridges were built in France and Germany as early as 1867. England began to build bridges of this type in 1871, and the United States in 1889. During the last decade of the nineteenth century construction of reinforced concrete bridges became widespread in the United States and abroad as engineers turned their attention to the potential advantages of the type. Promoters of concrete pointed to the longevity of concrete structures built by the Romans, and the fact that the structures were fireproof, rustproof, maintenance free, low in cost, and built with locally available materials and labor (Herrold 1913:60; Marsh 1904:3; McKibben 1912:49-50).

In 1889, Ernest L. Ransome designed an early reinforced concrete arch for Golden Gate Park in San Francisco, and this structure likely incorporated twisted steel rod or bar reinforcement. Experimentation with metal reinforcement embedded in concrete continued through the nineteenth century and into the early twentieth century. The predominant type of reinforcement for concrete bridges through the end of the nineteenth century, however, employed beams rather than bars. Austrian engineer Joseph Melan patented a scheme for arched I-beam reinforcement in the United States in 1894. His scheme was later modified and patented by another Austrian

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engineer, Fritz von Emperger, who built a number of beam-reinforced arch bridges in the United States beginning in 1897 (Turneure and Maurer 1932:2ff).

The most important American engineer to design and build reinforced concrete bridges during this period was Edwin Thacher. In 1889, with twenty years of iron and steel bridge building experience behind him, Thacher began building reinforced concrete bridges for southern railroads. In 1894, Thacher designed a five-span arch over the Kansas River at Topeka, which, at 693', was the largest reinforced concrete bridge at the time and the first to utilize the elastic theory of arch design. This work established Thacher as the leader in the field (ASCE 1921:921; Buel 1904:215).

In 1895 the Austrian Society of Engineers and Architects published the results of five years of testing arches constructed of various materials, including "concrete-steel," the first term used by engineers to describe reinforced concrete. Thacher considered the research to be the most valuable contribution to the theory and practice of arch construction ever made and immediately began using the data to further develop his bridge designs. Thacher published one of the earliest specifications for concrete steel bridges in 1899, and patented a deformed reinforcing bar for concrete known as "Thacher bar," a predecessor of modern "re-bar" (ASCE 1921:921; Thacher 1899:179-181).

It was soon recognized that beam reinforcement required a substantial amount of steel, and bar reinforcement began to be explored as a more efficient use of material. Reinforcement bars required less steel and were lighter than beams, and they could be bent and placed in regions of high tensile stresses. By the early 1900s, various patented bar-reinforcement methods had been developed, each employing different shapes, patterns of surface deformation, and bending schemes. By the first decade of the twentieth century, reinforcing bars, or "rebars," had replaced beams as the preferred method of reinforcement (Taylor et al. 1928:452ff).

Public acceptance of structures once scorned as "mud bridges" followed quickly after the engineering profession gave its approval for the use of reinforced concrete in bridge building. Materials testing and the adoption of standards for reinforced concrete construction greatly facilitated its popularity. Between 1903 and 1916, the American Concrete Institute and the American Society of Civil Engineers Committee on Reinforced Concrete Highway Bridges and Culverts developed bridge classifications and appropriate load formulae for bridge design (Hool and Kinne 1924:446ff). Municipal highway departments, already engaged in standardization of contracting and construction, welcomed these specifications and results. By 1917, bridge historian J. A. L. Waddell asserted that for short-span city bridges, the use of reinforced concrete was nearly universal (Waddell 1917:783ff).

Another American engineer who made important contributions to the field of concrete bridges was Daniel B. Luten. In 1900 Luten formed a bridge engineering company in Indianapolis and

quickly emerged as a leader in the development and application of short-span concrete arch highway bridges. According to the 1937 edition of *Who's Who in Engineering*, Luten held fifty-two patents on improvements in concrete bridge design, and was the author of 100 articles in the technical press and the designer of approximately 15,000 bridges in use at the time (Downs 1937:851).

Concrete arch bridges are classified into four categories based on the way the dead load of the structure is carried: filled spandrel, closed spandrel, open spandrel, and through arches. The filled-spandrel arch consists of a barrel arch which carries filling material and terminates in closed longitudinal walls that act as retaining walls for the fill. Closed- and open-spandrel arch types carry the traffic loads to the arch ribs and contain no fill. The former type carry the deck loads by spandrel walls resting on the arch ribs, while the latter type carry the roadway loads to the arch ribs by spandrel columns. Through arches, or "rainbow" arches, consist of ribs which extend above the roadway and carry the deck loads by vertical hangers.

Initially, reinforced concrete arch bridges closely imitated the traditional, less-plastic stone masonry closed-spandrel barrel arches. However, as the structural advantages of reinforced concrete became apparent, the heavy filled barrel was lightened into ribs. This division of the arch barrel into ribs has been dated by historian Carl Condit to the 1898 small-span, two-ribbed highway bridges erected in Allegheny County, Pennsylvania, by state Public Roads Department Engineer F. W. Patterson. These bridges employed the predominant curved I-beam reinforcement of the time. In 1896, Edwin Thatcher patented a bridge design incorporating the basic elements of open-spandrel construction in vertical posts which carried deck loads to an arch rib. The open-spandrel walls not only gave the arch a lighter appearance, but also decreased the dead load, thereby allowing the concrete arch to become flatter and multi-centered, making longer spans possible. Designers were no longer limited to the semicircular or segmental arch form of the stone arch bridge (Turneure and Maurer 1932:3).

By 1906, with the opening of Philadelphia's Walnut Lane open-spandrel arch, the utility and attractiveness of that bridge form for municipal arch bridges were securely established. Subsequent texts in the 1910-1930 period actively promoted the reinforced concrete, open-spandrel ribbed arch as an effective choice for city engineers. Henry G. Tyrrell's (1911) *History of Bridge Engineering* recommended open-spandrel bridges with projecting or cantilevered sidewalks in preference to solid-spandrel filled arches. In the same book, Tyrrell stated that "reinforced concrete bridges are extensively used in parks. . .where architectural treatment is desired" (Tyrrell 1911:410), and he provided illustrations of numerous arch bridges in various urban settings. By 1928, the Taylor, Thompson, and Smulski handbook, *Concrete Plain and Reinforced*, suggested use of open-spandrel arches where the ratio of rise to span was large and the spans were longer than 100' (Taylor et al. 1928:439).

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The aesthetics of bridges designed for city park settings was addressed by engineers in the early twentieth century. In addition to the calculations for open-spandrel arches, Taylor, Thompson, and Smulski also outlined the advantages of concrete arch construction in their handbook. Permanency, small cost of upkeep, and reduction of vibration and noise are among the benefits mentioned; however, the aesthetic appearance of the bridge is given primary importance. The authors state that "an arch bridge lends itself admirably to artistic treatment" because of the ability of concrete to form ornamentation. Reconciling the new bridge construction to its surroundings is listed as another advantage of concrete arch construction, in that a bridge built in this design "may be fitted into a landscape without destroying any of its natural beauty" (Taylor et al. 1928:431).

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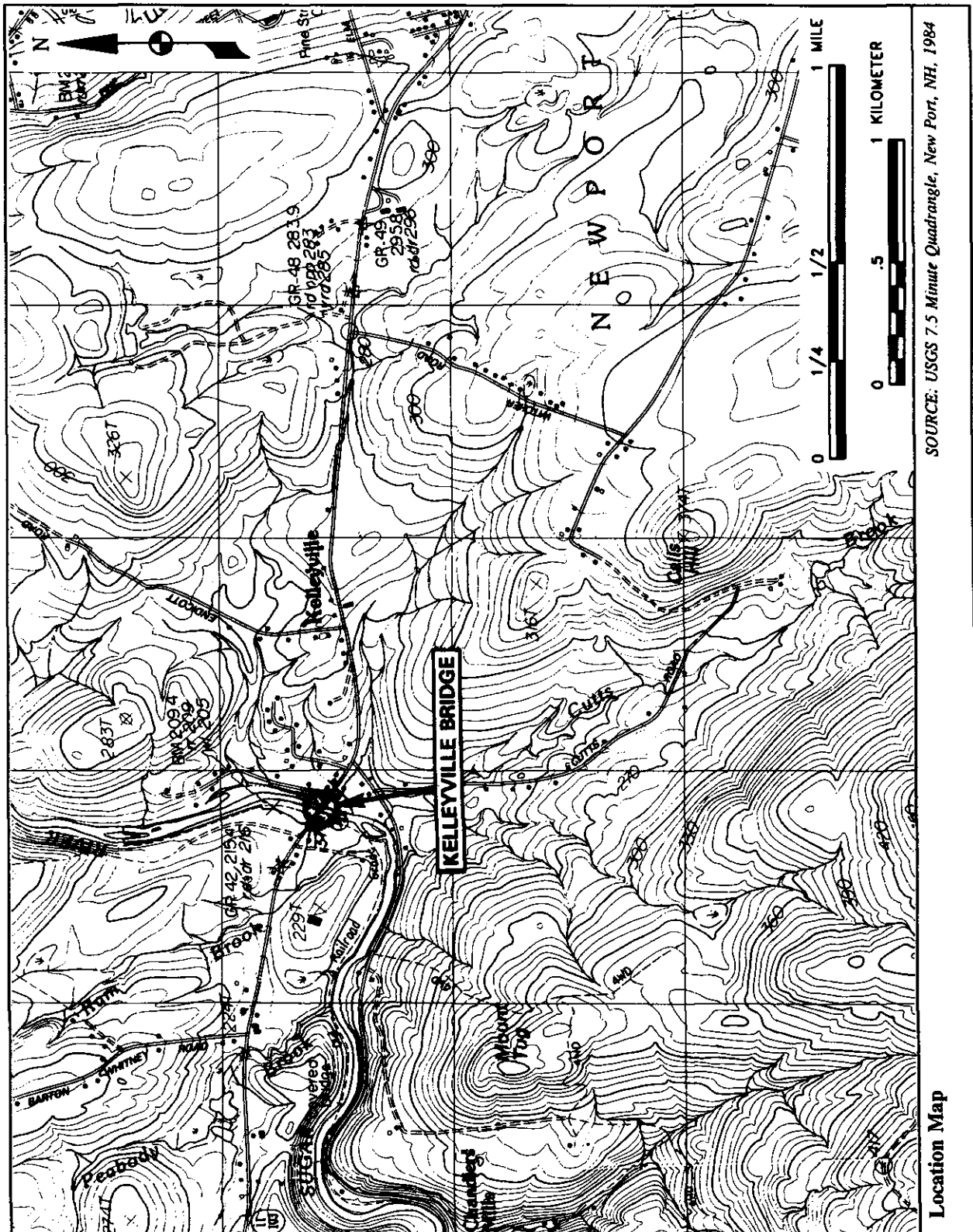
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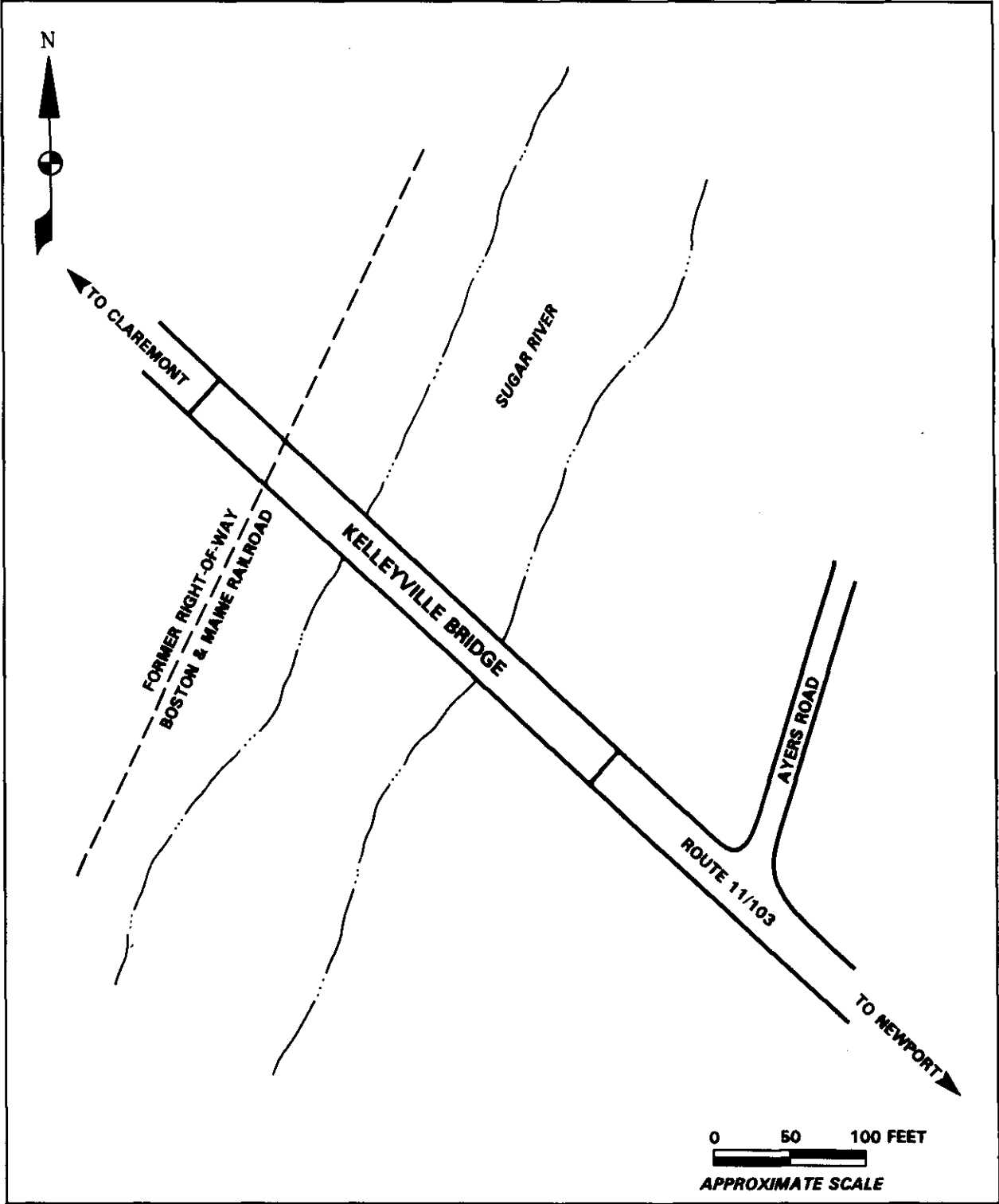
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Kelleyville Bridge, Site Sketch